Seat No.: _____ Enrolment No.

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER– V EXAMINATION – SUMMER 2020

Subject Code: 2150503 **Date:29/10/2020**

Subject Name: CHEMICAL ENGINEERING THERMODYNAMICS - II

Time: 02:30 PM TO 05:00 PM **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

			MARKS
Q.1	**(a)**	What are the characteristics of an ideal solution ?	**03**
	(b)	Discuss any two methods to determine fugacity of pure gases.	**04**
	(c)	Answer the followings:	**07**
	1	What do you mean by activity of pure fluid? How would you estimate activity of an incompressible fluid?	02
	2	How activity coefficient is related to the molar Excess Gibbs free energy in solution ?	01
	3	Why does the boiling point diagram at high pressures lie above that at a lower pressure?	01
	4	What do you mean by "extent of reaction "?	01
	5	What is the degree of freedom for the following non –reactive equilibrium system? Two partially miscible liquid phases are in equilibrium with vapor phase.	01
	6	How would you predict the feasibility of reaction from the value of the standard free energy change?	01
Q.2	**(a)**	Discuss effect of increasing pressure on T-x-y diagram in brief.	**03**
	(b)	Discuss Lewis-Randall rule, clearly mentioning its limitations.	**04**
	(c)	Define "Partial Molar property". Describe different methods to determine partial molar properties in detail.	**07**
		OR	
	(c)	Derive the equation for the criteria for phase equilibrium in terms of fugacity for mixture of N components and JI phases	**07**
Q.3	**(a)**	Discuss any two methods to check consistency of experimental VLE data in detail.	**03**
	(b)	Discuss effect of temperature and pressure on chemical potential.	**04**
	(c)	Prove that if Henry's law is obeyed by component 1 in a binary solution over certain concentration range, Lewis-Randall rule will be obeyed by component 2 over the same concentration range.	**07**
		OR	
Q.3	**(a)**	Discuss excess Gibbs free energy in brief.	**03**
	(b)	Discuss effect of temperature and pressure on equilibrium constant.	**04**
	(c)	Discuss van Laar and Margulies Equations in detail.	**07**
Q.4	**(a)**	Discuss phase rule for non reacting systems in brief.	**03**

(b) Derive equations for flash calculations. **04**

(c) The vapour pressures of acetone(1) and acetonitrile (2) can be evaluated by the following Antoine equations, where P is in kPa and T is in K. **07**

$$lnP_1^s = 14.5463 - \frac{2940.46}{T - 35.93}$$

$$lnP_2^s = 14.2724 - \frac{2945.47}{T - 49.15}$$

Assuming ideal solutions, calculate
1) x_1 and y_1 at 327 K and 65 kPa **2)** T and y_1 at 65 kPa and x_1= 0.4 **3)** P and y_1 at 327 K and x_1 = 0.4

OR

Q.4 **(a)** Discuss Duhem's Theorem briefly. **03**

(b) Write short note on VLE for completely immiscible systems with neat diagram. **04**

(c) The partial molar volumes of acetone and chloroform in a mixture in which mole fraction of acetone is 0.5307 are 74.166×10^{-6} m^3/mol and 80.235×10^{-6} m^3/mol respectively. What is the volume of 1 kg of the solution? **07**

Q.5 **(a)** Discuss effect of presence of Excess of reactants and products on equilibrium conversion. **03**

(b) Wilson's parameters Λ_{12} and Λ_{21} for the system nitromethane (1) and carbon tetrachloride(2) at 45 ℃ are 0.1156 and 0.2879 respectively. Calculate the activity coefficients of the components in a solution containing 30 mol % nitromethane. **04**

(c) Derive equation for standard heat of reaction. **07**

OR

Q.5 **(a)** Discuss Heterogeneous reaction equilibria with reference to "reactions in solutions". **03**

(b) Calculate the fugacity of pure ethylene at 100 bar and 373 K.The van der Waals constants are a = 0.453 J m^3/mol^2 and b = 0.571×10^{-4} m^3/mol and molar volume at 100 bar and 373 K = 2.072×10^{-4} m^3/mol. **04**

(c) Discuss minimum and maximum boiling azeotropes with neat sketch. **07**

****